ITU Telecommunication Standardization Sector
Study Group 15
Experts Group for ATM Video Coding
(Rapporteur's Group on Part of Q.2/15)

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Source: CHAIRMAN OF THE EXPERTS GROUP FOR ATM VIDEO CODING
Title: REPORT OF THE TWELFTH MEETING IN BOSTON AND NEW YORK (July 7-16, 1993) - Part III
Purpose: Report

Part I General (see AVC-553R)
Part II Sole sessions in Boston (see AVC-553R)
Part III Joint sessions in New York

Part III Joint Sessions with MPEG

Contents

1. Introduction

The joint sessions with MPEG were held at Columbia University in New York during 12-16 July 1993 at the kind invitation of Columbia University. At the opening session on 12 July, Dr. Dimitris Anastassiou made a welcoming address on behalf of the hosting organization.

The Experts Group appreciated the support and hospitality of the hosting organization.

A list of documents considered during the joint sessions is attached to this report as Annex 1.

2. REQUIREMENTS sub-group (S. Okubo)

2.1 Introduction

The REQUIREMENTS sub-group met every day during the week (July 12-16) under chairmanship of Sakae Okubo to freeze all the profiles at this meeting. We first reviewed all the documents on Monday and Tuesday to identify issues and spent the remaining days for discussing them.

In addition to our own sessions, we had joint sessions with other sub-groups as follows;

- with VIDEO and IMPLEMENTATION, 9:00 - 10:00 on Tuesday to identify open issues regarding the Next Profile and to seek advice of the two groups regarding specific items,
- with VIDEO and IMPLEMENTATION, 16;00 - 17:00 on Thursday to exchange views on the open issues.

In the following, relevant documents are first listed, then discussion and/or its conclusion are described.

2.2 Background

N0384	Convenor	Annex XV MPEG/Requirements meeting report (Sydney)
93/535	Haskell	Report of adhoc group on profiles and levels
93/540	Teichner	Report of adhoc group on requirements for verification test

The meeting started this week discussion with a short review of what happened in the previous Sydney meeting and identified items to be worked out at this meeting.

2.3 Next Profile and Profile Architecture

93/454	Teichner	Profile for hierarchical HDTV
93/467	Stevens	Information Technology (IT) profile
93/497	USNB	Contribution to ISO/IEC JTC1/SC29
93/514	Koster	Telecommunication requirements for the Next profile
93/515	Koster	Telecommunication levels for the Next profile
93/516	Sikora	Flexible Object Oriented Decoding Using Slice Identification
93/548	ITU-TS/Japan	Considerations on the next profile
93/549	ITU-TS/Japan	Practical examples of hierarchical coding
93/574	Australian NB	Australian National Body position on development of NEXT profile-1
93/575	Australian NB	Australian National Body position on development of NEXT profile-2
93/597	NHK	Amendment to pel aspect ratio
93/598	NHK, SONY	Syntax modification on subsampling ratio
93/600	BTA	Comments on MPEG93/473, Profile architecture
93/602	JNC Profile SG	Consideration on hierarchical profile architecture
93/603	JNC	Comments for WG11 New York meeting
93/642	AFNOR	Resolutions of the French National Body
93/654	Erdem	10-bit/8-bit amplitude scalable coding
93/659	NNI	Resolutions of the Dutch National Body
93/687	McCann	WGDTVB contribution to "Next Profile" definition
93/690	Fautier	Proposal of SIMPLE PROFILE parameters
93/693	Challapall	Constraints on MPEG2 Syntax for the U.S. HDTV Standard
93/707	Wilson	Discussion with SMPTE on professional applications
93/720	NHK	Consideration on copyright management for video data
93/726	McLaren	HDTV simulation results

The discussion was focused on freezing all profiles and levels so that the structure of the generic standard be finalized at this meeting. Most of the time was spent on specifying the Next Profile and defining higher levels than the Main Level. This work was carried out with collaboration of Video, Implementation and Systems sub-groups; see Annex 2 to this report for the questions we asked each sub-group.

The outcome is contained in WG11 N0489 which is attached to this report as Annex 3. It should be noted that N0489 also indicates some open issues toward the Brussels meeting.

1) Definition of Level Parameters, particularly those of High

We decided to follow the practice for the Main Level; upper bounds are specified for pels per line, lines per frame, frames per second and the product for the three. The decoder is also required to support pels per line and lines per frame in multiples of 16 (Note).

> *Note* - In the joint sessions, it was pointed out that the number of lines per frame should be a multiple of 32 to support the field structure. This aspect is yet to be sorted out.

The following existing or planned HDTV formats were considered;

Format	Number of Y pels per frame	Number of Y pels per second
1440x1040x30 (active lines: 1035)	1.50 million	44.9 million
1920x1040x30 (active lines: 1035)	2.00	59.9
1440x1152x25	1.66	41.5
1920x1152x25	2.21	55.3
1920x1088x30 (active lines: 1080)	2.09	62.7

1440x1088x30 (active lines: 1080)	1.57	47.0
2048x1152x25	2.36	59.0
1280x720x60	0.922	55.3

There was extensive discussion as to whether the number of HDTV related levels can be one (1920 pels per line) or it should be two (1920 and 1440 pels per line). We adopted the two level solution since there were expressed sufficient application interests in both levels and since the advice of Implementation sub-group indicated possible significant difference of hardware impacts between the two levels.

In the course of this discussion, Mr. Gaggioni informed the meeting about the digital VTR for HDTV that minor changes to the existing 1125-line equipment (1035 active lines) easily allow accommodation of the 1920x1080 pels per frame picture format being considered in the US.

There was a request to include 960x496x30 as a new Level or as the Main Level of the Next Profile. Though the Implementation sub-group's advice indicated that there may not be a threshold between 960x496x30 and 720x480x30, it was objected to define a new Level on the grounds that 960x496x30 is less likely to appear as the top layer of the hierarchical coding and that this causes an outstanding irregularity in the Profile/Level structure. In conclusion, we agreed to extend the upper bound of pel rate to 11.6 million per sec for the Main Level of the Next Profile. to cover 483 active lines of the 525/60 television system and to minimize the irregularity of the Profile architecture.

2) Specifications for the Next Profile

Starting from the skeleton produced in Sydney, we refined the specifications according to the comments provided in MPEG93/600, 687 and expressed during the discussion. The highlight functionality is scalability supporting;

- up to 2 resolution scales
- up to 4 scales in total as combination of resolution scales and SNR scales
- up to 2 SNR scales at the upper resolution scale

at High and High-1440 Levels.

There was a request for flexible format relationship between the base layer and upper layer resolutions (MPEG93/598), which was agreed and conveyed to the Video sub-group for their action.

3) Necessity of Simple Profile and its specifications

There was some discussion as to whether we should define the Simple Profile at all. The objective is to simplify the standard structure and allow interworking between different applications to the maximum extent.

Practical significance of less costly implementation in the near future, however, was also recognized. The meeting concluded to define the Simple Profile, but with the following specifications;

- Its functionalities should be those of the Main minus B-picture to ease migration to the Main in the future when implementation cost of B-picture become less significant.
- The Simple Profile decoder should be able to decode the Main Profile bitstreams at lower levels as proposed by MPEG93/603.

4) Compatibility between different Profiles and Levels

Taking into account the above mentioned relationship between the Simple and the Main, the bitstreams each decoder must be able to decode was summarized as in the table/§4 of N0498.

5) Coding tools not included in defined Profiles

There are some coding tools (4:4:4, 10/8 bit scalability, data partitioning, etc.) which are defined in the syntax but not included in any Profile. These tools may be included in one or other Profiles which can be added in the future according to the existing procedures (e.g. in form of Amendment) if found necessary. Another possibility is that their use may be defined in application standards. The November 1993 CD includes only Simple, Main and Next Profiles.

The procedures of adding new profiles have been clarified with the help of Convenor.

6) Pel aspect ratio

It was agreed to include three values; 0.7500, 0.7826, 1.0435.

7) Indication of objects

The meeting supported the idea proposed in MPEG93/516, leaving the syntax representation to the Video's description.

8) Copyright management indication

There was a proposal to include the indication in the video elementary stream (MPEG93/720). Since it impacts the frozen syntax and the video should always be accompanied by the Systems layer for correct operation, we concluded that the indication should be supported by the Systems.

9) Progressive/interlace scalability

This requirement was reconfirmed in the joint sessions with Video and Implementation (see one of the open issues identified in Sydney - Annex XV to N0384).

10) Possibility of integrating spatial scalability and frequency scalability

Mr. Holtzman provided a thought containing examples of using various combinations of spatial domain, frequency domain and SNR scalability. The meeting requested him to raise his thought in the Video and Implementation sub-groups for their consideration. Eventually the frozen syntax allowed simultaneous use of spatial scalability and SNR scalability, while excluding frequency domain scalability entirely.

11) Table relating syntactic elements and Profiles

This is to be worked out through correspondence toward the next meeting in Brussels.

2.4 Requirements for Audio

497	USNB	Contribution to ISO/IEC JTC1/SC29

It was raised whether non-backward compatibility with MPEG-1 be considered as part of the MPEG-2 requirements. The meeting concluded that the normative requirements for the MPEG-2 audio had just been finalized in Sydney stipulating the backward compatibility, thus how to handle the non-backward compatible mode in the course of future activities should be resolved in the Audio sub-group.

2.5 Verification

488	Nasse	Revision of MPEG-2 verification procedure proposed by MPEG adhoc "test"
490	Hidaka	Method of MPEG-2 verification test
525	Hidaka	Report of adhoc group on MPEG-2 verification test

556	Hidaka	Method of subjective assessment for MPEG-2 verification test
640	Teichner	Issues for verification test

Unfortunately we could not deal with this topic due to time limitation. We will continue this work through correspondence toward the next meeting in Brussels.

3. VIDEO sub-group (G. Bjøntegaard)

The video group met throughout the whole week. There were joint meetings with requirements and implementation. Besides there was parallel work going on concerning update of the video WD.

The areas of work in the video group were:

- Performance of MP@ML.
- MPEG2 extensions and elements for NEXT profile.
- Freezing if technical tools to fulfil the requirements.
- Production of the 3rd WD.
- Conformance testing.

3.1 MPEG2 extensions and tools for NEXT profile.

AC leaky prediction:

There was a proposal from the Grand Alliance (US) to include AC leaky prediction as an alternative to achieve regular update and error resilience. The proposal was rejected because it failed to show significant benefits over the existing tools.

8x1 DCT and 16x8 motion compensation for proscan:

Those tools have been considered several times before and were brought up again. Both were rejected because they failed to show significant benefits over the existing tools.

Scalability:

The main activity is on spatial scalability. Tests are still being performed on optimizing scaling filters. Concerning the number of spatial levels, it was agreed that 2 was enough. If more levels were needed this could be met by using SNR scalability in addition. Data Partitioning is another way of obtaining one sort of scalability. It was agreed that this tool works mainly for error resilience. The pictures resulting from the different layers are not considered suitable for presentation separately. There was a strong view in the group that DP was an unnecessary tool. The only area where it was felt useful was with ATM transmission and different priorities. It is therefore up to the ATM group to reconsider if DP is of significant benefit.

FF/FR:

It was realized that this was largely a pure VCR concern and that general "bitstream producers" would not have to do any effort to facilitate FF/FR in a VCR. The interaction between Video and Systems needs more work on this item.

3.2 Production of the 3rd WD.

Several documents concerning inconsistencies/errors in the WD were presented. At the same time editorial work on the WD was going on during the whole week.

Skipped pictures.

This item was of particular interest for low delay. The ATM group had an input document on this issue. This document was merged with another document on VBV operation and 3:2 pull down. The result will appear in the WD.

3.3 Conformance testing.

There was a strong urge for activity on conformance testing for the coming meetings!

3.4 New experiments.

Since most of the elements are frozen, there is little need for more experiments. However, there are still a few items left for optimization. This is concerned with:

- Spatial scaling filters.
- Block type VLC optimization.

4. IMPLEMENTATION STUDIES sub-group (G. Morrison)

The IMPLEMENTATION STUDIES sub-group met on 13th, 15th and 16th of July during the WG11 meeting at Columbia University, New York. Core participants were:

Geoff Morrison	BT Labs (chair)
Richard Bramley	SGS-Thomson
Peter Borgwardt	Tektronix
Sam Narasimhan	Singapore Institute of Microelectronics
Marco Gandini	CSELT
Fathy Yassa	Thomson Consumer Electronics Components
Barth Canfield	Thomson Consumer Electronics
Tom McCarthy	IBM

The topics discussed were:

4.1 AC Leak

Though we had previously expressed a dislike of AC Leaky prediction at the Sydney meeting we considered new inputs addressing the implementation aspects which had been the reasons for that stance.

Document MPEG93/581 proposed the use of 4 by 4 groups of pixels (instead of one 8 by 8 group) for computing the DC value to be subtracted from pels to obtain the AC values which would then be subjected to the leak. We considered that though this initially appeared to reduce the size of on-chip RAM it did not eliminate it nor would the accompanying control circuitry be much reduced. However, it was subsequently realised that as a 4 by 4 block is not a natural nor desirable structure for use after the leak, an extra conversion stage would be required, probably to raster scan or 8 by 8 block. Therefore any simplification in the vicinity of the leak would be outweighed elsewhere.

Document MPEG93/581 also proposed an alternative of using a quasi average (of the pixels already available) as the DC value to be subtracted. This would completely eliminate any requirement to temporarily store pels while an average is being computed on an entire block. However, this proposal requires division by 2, 3, 4, 5, ...64 which we considered more complex than the 64 byte buffer we had disliked in Sydney.

Document MPEG93/587 proposed a rearrangement which eliminated the 64 byte buffer by effectively combining it with the FIFO buffer normally needed to interface writing to the frame memories of the predictor loop. We were not convinced that this sharing could be accomplished without increasing the size of the FIFO.

At this point, where we had no reason to change the opinion we formed at the previous meeting in Sydney, we learned that AC leak had been withdrawn.

4.2 Data Partitioning for VCRs

An ad-hoc group had concluded that data partitioning would aid fast forward and fast reverse modes for video recorders. We were asked to comment on the cost savings that would result if "dumb" recorders were only presented with coded bitstreams which were partitioned. Incorporating extra circuitry to take non-partitioned coded data and partition it would make "smart" VCRs more expensive.

We assessed the extra requirement on a "smart" VCR as being a Variable Length Decoder and counters but no extra buffer, to produce high priority data. On the replay side, no recombining is necessary if the VCR records non-partitioned and high priority versions.

The cost of the "dumb" VCR approach falls on the TV with integral MPEG-2 decoder. This cannot be Main Profile at Main Level (because MP@ML does not include data partitioning) and the decoder has extra buffer management.

We concluded that on the grounds of equipment cost, both are relatively small and the difference between them would be very small and of uncertain sign. We recommended that the decision be made on other considerations and posed the following questions:

- Is the data partitioning split for FF/FR exactly the same as broadcasters would wish for error resilience?
- Is it feasible to define a unique data partitioning split which will be the same across all storage devices and generations of them?
- How desirable is operation with MP@ML?
- Is it important to permit product differentiation through various qualities or speed-up factors of FF/FR, including none?

We recommended the "smart" VCR as the solution because:

- No constraints on the bitstreams it can record so no conflicts between VCR manufacturers and broadcasters, ATM network providers etc.
- New VCR formats can be developed over time with split ratios which are appropriate to each format.
- Full operation with MP@ML.

4.3 Implementation considerations for definition of HIGH LEVEL

We were requested by the REQUIREMENTS sub-group to provide guidance in the definition of HIGH LEVEL. In particular we were asked to comment on the impact of scanning formats and where they fell in relation to breakpoints of memory size etc.

Widespread use of a HIGH LEVEL will depend on low cost decoders and these need to have only a small number of memory devices. As sufficiently large and fast devices are not available we had to make an assumption. We based our analysis on hypothetical Synchronous DRAMs operating at 100 MHz.

We had been given a table of possible formats by the REQUIREMENTS sub-group and added the Main Profile @ Main Level for reference purposes. We computed the required memory size required for two cases. The first is without B frames and without Dual Prime. The second is with B frames and Dual Prime. These memory sizes are listed in Table 1. The additional [1]s and [2]s in the boxes indicate which will fit in 32 Mbytes at 64 bits bus width and 64 Mbytes at 128 bits bus width respectively. As some will fit in neither a third marker, [3], shows those which will fit in 64 Mbytes if B frames are not used but Dual Prime is retained.

Table 1

Format	Y pels per frame (10^6)	Y pels per sec (10^6)	Memory reqd without B frames, without Dual Prime (10^6 bit)	Memory reqd with B frames, with Dual Prime (10^6 bit)
ML@MP		10.4	<8	16
1440x1040x30 (1035 active lines)	1.50	44.9	28.1 [1]	61.9 [2]
1920x1040x30 (1035 active lines)	2.00	59.9	34.9 [2]	79.9 [3]
1440x1152x25	1.66	41.5	30.1 [1]	67.7 [2]
1920x1152x25	2.21	55.3	37.5 [2]	87.6 [3]
1920x1088x30 (1080 active lines)	2.09	62.7	36.0 [2]	83.2 [3]
1440x1088x30 (1080 active lines)	1.57	47.0	29.0 [1]	64.4 [2]
2048x1152x25	2.36	59.0	39.4 [2]	92.9 [3]
1280x720x60	0.922	55.3	21.0 [1]	41.1 [2]

[1] 32 Mbit, 64 bit wide
[2] 64 Mbit, 128 bit wide
[3] 64 Mbit, 128 bit wide, NO B FRAMES but with Dual Prime

Assumptions

- 100 MHz Synchronous DRAM devices
- all formats are 4:2:0
- vertical motion vector magnitude <128
- without B frames, needs 1 frame + 128 lines + coded data buffer
- with B frames, needs 3 frames + coded data buffer
- coded bit buffer is $8x10^6$ bit for all except MP@ML

Concerning the maximum coded data rate for HIGH LEVEL, we were of the opinion that rates up to about 80 Mbit/s would not be unduly difficult.

4.4 HIGH LEVEL decoding with parallel architectures

There was general agreement that parallel processing of sub-pictures may be an attractive method of handling larger formats and that this would be greatly eased by having more slice headers than the current minimum.

4.5 Oddification for IDCT mismatch control

Some problems had come to light with the oddification method agreed at the Sydney meeting and solutions discussed in an ad hoc group. We endorsed the sequence of first limiting coefficients to be within the range -2048 to 2047 and then toggling the LSB in twos complement notation of the 64th coefficient subject to the summation criterion agreed in Sydney. We also endorsed the proposal in Document MPEG93/595 that in frequency scalable schemes, oddification only be performed in the 8 by 8 case.

4.6 Upsampling filters for Spatial Scalability

We were requested by the VIDEO sub-group to comment on polyphase filters required for upsampling in spatial scalability. We suggested the use of bilinear interpolation filters with output positions quantised to the nearest of sixteenth of input sample spacing.

4.7 Interworking between elements in profile/level matrix

We recognised that the capability of actual implementations of MPEG-2 video will not map directly unto rectangular areas of the profile/level matrix. It is likely for example that a decoder for a certain level of the next level would have enough processing power to handle a higher level in the main profile. Consequently we recommended that MPEG should take this into account as had been requested by the Japan National Body and mandate such interworking between suitable entries in the profile/level matrix.

4.8 Gaps between slices in intra frames

We saw no reason why gaps between slices in intra frames should be prohibited.

4.9 Implementation impact of number of layers of spatial scalability

We were requested by the REQUIREMENTS sub-group to advise on the implementation impact of the number of layers of spatial scalability.

For the version of SNR scalability which is prone to drift in the lower layers, the memory size and speed is independent of number of layers. Each layer requires input coded data buffer management, VLD/parser and inverse quantiser. The hardware may be multiplexed but speed required increases linearly with number of layers.

The other version of SNR scalability (which is drift free), when used with frame based coding and interlaced display, needs an additional half frame memory to interlace the higher layer. However, we understood that this version was no longer being considered by the VIDEO subgroup.

For spatial scalability the memory size, memory speed, parser/VLD speed, inverse quantiser speed, IDCT speed increase with total number of pels in all layers. Adding one lower layer downsampled by 2:1 vertically and horizontally causes 25% increase. Adding another takes 6.25% more (31.25% total above one layer). A third layer needs another 1.5625%. The limit for any number of such 2:1 downsampled layers is 33.333%.

Resolutions

We prepared resolutions on the above topics. They are contained in §3.5 of Document ISO/IEC JTC1/SC29/WG11 N0460.

5. SYSTEMS sub-group (S. Dunstan)

5.1 Introduction

An MPEG Systems Ad Hoc Group to Recommend Revisions to the Systems Working Draft meeting was held at Columbia University on the weekend immediately prior to the 23rd meeting of MPEG. At the Sunday meeting the liaison document from the SG15 Experts Group was presented [1].

The Systems Working Draft was frozen at the end of the New York meeting. However some technical issues remain to be resolved and further editing of the Working Draft is required. An Ad Hoc Group to Verify the Working Draft was established.

5.2 H.32X terminal

With respect to the H.32X terminal the interests of the Experts Group, as contained in [1], can be summarised as,

- the Packetised Elementary Stream (PES) is seen as a likely candidate for H.22X. (The Program Stream may also be suitable).

- H.22X should not substantially increase end to end delay.
- H.22X should not prohibit alignment between structure in elementary streams and H.22X structure i.e. a PES packet.
- a H.32X terminal requires only one time base.

With respect to the PES stream, the Elementary Stream Clock Reference remains in the PES header. The PES stream is thus capable of supporting MPEG-2 timing, without use of the Program Stream or the Transport Stream.

The low end to end to delay requirement had impact upon

- the **PES_packet_length** field.

  this field is contained in the PES packet header. Concern was expressed about the delay that this field introduces when the packet length is known only after coding is complete. The result was that where the PES packet length field is zero, the packet length is undefined. However it may be undefined only where the following conditions exist

  - the PES packet carries MPEG video
  - the PES packet is part of a Transport Stream

  This later condition may be unsatisfactory to the Experts Group, given the low delay requirement and the desire to use the PES layer for H.22X. This should be addressed.

- the PES **previous_PES_packet_CRC** field

  this field is contained in the PES packet header, and its purpose is that of error monitoring. The field is not intended to be used as a mechanism to accept or reject PES packets at the decoder. The CRC result of the current PES packet is placed in the header of the next PES packet. This avoids delay that would occur if the result was contained in the header of the current packet.

Alignment between elementary stream structure and the PES packet was not only prohibited, but actively supported as follows

- a one bit field **data_alignment_indicator** in the PES packet header indicates if an elementary stream structure begins at the start of the PES payload. Compliant decoders however must not require this bit to be set.
- in the Program Specific Information (PSI) table a **data_stream_alignment_descriptor** indicates the type of structure in the elementary stream to which the PES packet is aligned e.g. slice start code.

It was noted in the meeting that both the PES **packet_start_code_prefix** (24 bits) and the **PES_packet_length** (16 bits) fields may be redundant in some applications, since the preservation of the PES packet may be carried out by a lower layer function e.g. Transport Stream, AAL etc. It was agreed that the **packet_start_code_prefix** field should remain for the sake of compatibility with the Program Stream, for which it is required.

5.3 Transport Stream and ATM/AAL

The transport packet length has been fixed at 188 bytes. The following reasons were put forward to justify this length

- scrambling

  the length suits scrambling algorithms

- ATM mapping

this length allows mapping of one Transport Packet to four ATM cells, with one byte per cell reserved for AAL functions. MPEG says nothing about what these functions are or should be.

The packet length decision is based on the assumption that there should be alignment between the start of a Transport Packet and the ATM cell payload. The use of AAL type 1 however does not preclude other packet lengths; packet structure is maintained through use of the pointer field, and protection against cell loss is provided by Reed Solomon coding and byte interleaving.

- buffering, packet loss

  a packet length of 188 bytes is preferable to a longer packet length for reasons of buffering requirements, and to minimise the effects of errors in the case of packet loss.

5.4 Other MPEG System issues

Other issues dealt with by MPEG Systems included the following,

- definition of a System Target Decoder for the Transport Stream
- compatibility

  the PES header has an optional field that carries an MPEG-1 systems pack header or an MPEG-2 Program Stream pack header. This mechanism allows an MPEG-2 Program Stream to decode an MPEG-1 System, and supports conversion between MPEG-2 Program and MPEG-2 Transport Streams.

- Program Specific Information (PSI)

  for the Transport Stream, syntax is defined that associates the elementary streams into complete programs. Transport Stream packets with the **PID** field set to zero carry the **Program Association Table**. This table is a list of PIDs, each of which carry a **Program Map Table**. The **Program Map Table** lists the PIDs of the elementary streams for that program, and may contain a set of descriptors for the program, as well as a set of descriptors for each elementary stream within the program.

  There is an intention to use the PSI syntax also in the Program Stream.

- timestamp discontinuity

  a flag is contained in the adaptation field of the Transport Stream packet to indicate that the PCR value contained in this packet may be discontinous in relation to previous values.

- Transport Stream redundancy

  the **continuity_counter** field in the Transport Stream packet header has the semantics that if the value in a particular PID is the same as the previous value in the same PID, then this packet is a duplicate of the previous packet.

- splicing point

  a **splice_countdown** field is available in the Transport Stream adaptation field that indicates the number of packets before a suitable splice point occurs. The current semantics of this field may need to be qualified with "... **non-redundant** number of packets ..." (see Transport Stream redundancy above).

- DSM trick mode support

  a one byte field is available in the PES header for DSM trick mode control. The semantics of this field are to be defined in Brussels.

- scrambling constraints

in the Transport Stream the Transport Stream packet header, including the adaptation field,must not be scrambled. In the Program Stream the pack header and the PES packet header must not be scrambled.

- copy control

  the PES header contains a one bit **copyright** flag and an **original_or_copy** flag for copy control. An **additional_copy_info_flag** is also available that opens up a one byte field.

5.5 MPEG-2 timing model

TD7 from the Boston meeting of the Experts Group was concerned with the MPEG-2 timing model and clock recovery, where the Transport Stream was transported by AAL type 1. TD7 was presented to the Systems meeting for clarification. Figure 1, and the following text, attempt to reflect the MPEG-2 timing model as described in the Systems working draft, and as discussed in the Systems meeting.

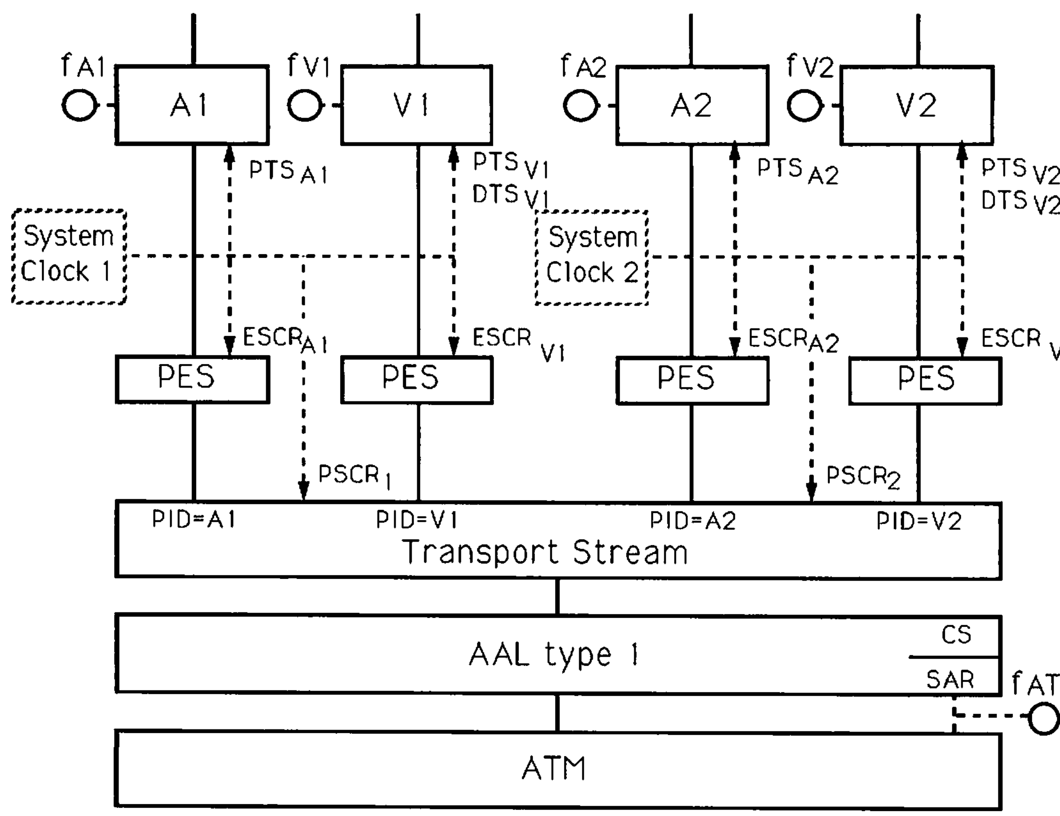

Figure 1. Illustration of MPEG-2 timing model using Transport Stream and AAL type 1 (TD7).

- system clock

  a program is defined as a collection of elementary streams with a common system clock, or time base. The system clock frequency is nominally 27 MHz. Time stamps and clock references are snapshots of this system clock.

- time stamps

  Presentation Time Stamps (PTS) are snapshots of the system clock but with a resolution of 90 kHz. They refer to the time that an access unit (video or audio frame) is to be presented by the system target decoder. Decoding Time Stamps (DTS) are similar but refer to the time that an access unit is to be decoded. DTSs are only required in elementary streams in which the access unit decoding order differs from the presentation order e.g. I, P frames.

- clock references

clock references are snapshots of the system clock, and have a base resolution of 90 kHz with an extension to 27 MHz resolution. They refer to the time that the last byte of the clock reference field enters the system target decoder. Table 2 identifies the name and location of clock references for each of the MPEG-2 streams.

stream	clock reference	location
Elementary Stream	ESCR	PES header
Transport Stream	PCR	TS adaptation field
Program Stream	SCR	pack header

Table 2. MPEG-2 streams and clock references.

The ESCR field is not required where the PES packet exists as part of the Program Stream or Transport Stream.

- lock flags

  the audio and video sampling clocks may be locked to the system clock. In this case the appropriate indicator bits may be set in the system header and in the PSI area of the Program Stream and Transport Stream respectively.

- rate flags

  in the Program Stream the **program_mux_rate** in the pack header indicates in bytes/sec the rate of the data in the pack in which it is carried. This field is used in the calculation of arrival time of the next byte in the system target decoder. In the Transport Stream the equivalent value **transport_rate** is not coded in a field, but derived from the number of bytes received between two successive PCR values. An Elementary Stream rate field **ES_rate** is also available. It is used to derive the time of arrival of the next byte at the system target decoder for PES streams.

In response to TD7,

- the Transport Stream carries multiple PCRs, one for each program carried.
- the audio and video sampling clocks can be derived from the system clock, when the respective lock flags indicate this. When lock does not occur, it is the decoder's responsibility to deal with this situation.
- AAL type 1 takes part in jitter removal for the whole Transport Stream. However the decoder might further remove jitter for each program, in order to accurately reconstruct each program's system clock.

Further discussion may be required to answer all the issues raised by TD7.

References

[1] ISO MPEG 93/698, "Report of discussion on ATM/AAL and MPEG-2 Systems", ITU-TS SG15 Experts Group on ATM Video Coding.

END

* * *

Annexes

Annex 1	List of Documents for the Joint Sessions in New York
Annex 2	Questions to the Video and Implementation sub-groups
Annex 3	Agreements on Profile/Level

List of Documents for the Joint Sessions in New York (MPEG93/???)

???	Source	Title
486	Convenor	Seminar on MPEG-4 Columbia University 93/07/14
487	A. McMahon	HDTV Display Configuration used in Canberra 28 March 1993
488	D. Nasse	Revision of MPEG-2 verification procedure proposed by MPEG ad-hoc "test"
489	M. Delahoy	New Video Test Sequence for 625/50 MPEG-2 Verification Testing
490	T. Hidaka	Method of MPEG-2 Verification Test
491	M.Smith et al	Report on the Meeting of MPEG and intellectual property rights
492	CEC DGXIII	Invitation to MPEG Meeting in Brussels 6-10/9/93
493	O. Poncin	Performances of the Mail Profile @ Main Level (distributive and interactive services)
494	O. Poncin	MPEG-2/H.2BX error resilience based on data partitioning
495	O. Poncin	New results on spatial scalability
496	German National Body (DIN)	Some more Exploration on the Patent issue (ETSI IPR)
497	USNB	Contribution to ISO/IEC JTC 1/SC 29
498	G. Waters	Statement on Standards for digital television broadcasting
499	I. Sebestyen	The SpR's Report on some "lessons learned" regarding current patent policy practice of joint CCITT and ISO/IEC recommendations/standards
500	CCIR SG	Liaison statement to working party 11D
501	C. Kirby	Digital multi-programme television emissions within a satellite transponder
502	C. Kirby	Transfer of the CMTT and establishment of Telecommunication Standardization Study Group 9
503	CCIR SG	Cascading motion compensation processes
504	CCIR SG	Report of the Chairman of Task Group 11/3 to Study Group 11
505	CCIR SG	Report of the First Meeting of Task Group 11/3
506	ITU RSG	Report on the Second Meeting of Task Group 11/4
507	ITU RSG	Joint VPA Study Project
508	ITU RSG	Liaison statement from Task Group 11/4 to MPEG - Comments to main (or core) profile of MPEG-2
509	ITU RSG	Liaison statement to MPEG from radiocommunication Task Group 11/4 on the number of active lines for distribution of 525 signals.
510	K. Brannon	Letter from the ISO/IEC ITTF to the Internet Society on Liaison with ISO/IEC JTC 1
511	Bellcore	Transport Packet Size and the Mapping to ATM
512	A. Nicoulin	Letter to Ms. N. Hirose on Very-low Bitrate Audio-Visual Coding
513	N. Hirose	Letter to Mr. A. Nicoulin on Very-Low Bitrate Audio- Visual Coding
514	Koster et al	Telecommunication requirements for the Next profile
515	Koster et al	Telecommunication levels for the Next profile
516	T. Sikora	Flexible Object Oriented Decoding Using Slice Identification
517	T. Sikora	FF/FR using Frequency Scalable Layered Coding
518	D. Pearson	Video Coding Techniques for very low bit rates
519	F. Laczko	Informal communication to BR TG 10/3
520	C.F.Holborow	Adaptation headers and two-layer synchronous packet structure
521	C.E.Holborow	Proposed synchronization byte for MPEG systems packets
522	A.R.Reibman	Packet loss effect on video SNR: simulation results for 188 byte and 236 byte packets
523	I.Rabowsky	Proposal to modify picture pan-scan extension syntax
524	Williams	Report of ad-hoc group on audio-visual lossless coding
525	Hidaka	Report of ad-hoc group on MPEG2 verification test
526	Koster	Report of ad-hoc group on Test model editing
527	Le Gall	Report of ad-hoc group on Video Working Draft
528	Biggar	Report of ad-hoc group on error resilience and cell loss
529	Sikora	Report of ad-hoc group on layered coding
530	Yagasaki	Report of ad-hoc group on tools for storage media
531	Fogg	Report of ad-hoc group on technical report
532	Decotignie	Report of ad-hoc group to recommend revisions to the Systems WD
533	McGrath	Report of ad-hoc group on relationships to ATM AAL
534	Kogure	Report of ad-hoc group on the development of DSM CC
535	Haskell	Report of ad-hoc group on profiles and levels
536	Stoll	Report of ad-hoc group on ATM transmission of audio-coded signals
537	Pan	Report of ad-hoc group on audio software simulation

538	van de Kerkhof	Report of ad-hoc group on audio working draft editing
539	Laczko	Report of ad-hoc group on audio working development
540	Teichner	Report of ad-hoc group on requirements for test verification
541	Savatier	Report of ad-hoc group on syntax verification and bitstream exchange
542	Futa	Report of ad-hoc group on Resolution 12 of Sydney meeting
543	A.Koster	Inter working between wide screen SCIF and SCIF video conferencing systems
544	I. Rabowsky	Program Stream Description Table
545	A.Koster	Software decoding of video streams
546	TSS/J	Time stamp for a large picture
547	TSS/J	Considerations on AC-leaky Prediction
548	TSS/J	Considerations on the next profile
549	TSS/J	Practical examples of Hierarchical coding
550	TSS/J	Syntax modification for compatibility/spatial scalability
551	TSS/J	VBV operation in 3:2 pulldown
552	TSS/J	Some considerations on the the coding segments
553	TSS/J	Relation between MPEG-2 transport mux and ATM/AAL and several possible candidate for AAL
554	Yamashita	JCC on Audiovisual/Multimedia Services (AVMMS)
555	Korea	Invitation to 25th MPEG Meeting
556	Hidaka	Method of Subjective assessment for MPEG-2 Verification Test
557	Hidaka	Test items for MPEG-2 Verification Test
558	R.Schaphorst	Liaison document from the TSS Rapporteur Group for Very Low Bitrate Visual Telephony
559	Wells et al	Specification of up sampling filters in Hierarchical systems
560	ter Horst et al	Systems Video 'Relation' Stream
561	Koster et al	On the B-frame design complexity of spatio-temporal weighting
562	A.Wise	Erratum to the Sydney Video Working Draft
563	A.Wise	Points for clarifications in the video working draft
564	A.Wise	Sampling Structure in MPEG-2
565	A.Wise	New text for clause 7
566	Whittington	A proposal for archiving e-mail for ad-hoc groups
567	S.Dunstan	"H.32X terminal and MPEG-2 Systems"
568	S.Dunstan	"B-ISDN & Video Services Tutorial"
569	J.Y.Nam	Comparison of CTV/HDTV compatible coding schemes
570	Hitachi	Syntax Proposal for FF/FR bitstreams
571	Hitachi	Issues for Digital VCR Compatibility
572	Hitachi	Results of Experiment with Data Partitioning for FF/FR
573	T. Savatier	Improvement of the Video Buffering Verifier (Annex C)
574	Australia N.B.	Australian National Body position on development of NEXT profile-1
575	Australia N.B.	Australian National Body position on development of NEXT profile-2
576	L.Cuvelier	Comments on the two-layer scalable encoder structure
577	ISO	IS 639 Code for the representation of names of languages
578	Stampleman	The Program Stream Directory
579	Fernando et al.	Comments on the systems transport multiplex
580	K. Sugiyama	Results of 8x1DCT Coding
581	K. Sugiyama	Results of AC-Leaky Prediction
582	K. Sugiyama	Comment about the B-Picture
583	K. Tahara et al.	Comments for WD-4
584	Y. Yagasaki et al.	Comments for FF/FR bitstreams in Profiles
585	Y. Yagasaki et al.	Syntax extension for Fast Forward/Reverse at Strage Media
586	Y. Yagasaki	Modification of iDCT mismatch control
587	M. Veltman	An Alternative AC leaky prediction method
588	M. Veltman	Increasing the effectiveness of the MPEG 2 directory
589	M. Veltman	Reducing overhead for locked encoded (and other) AV multiplex bit streams.
590	M. Veltman	Supporting bursty video bit rate applications with lower transmission bit rates.
591	- not assigned -	
592	N. Yanagihara	FF/FR Scheme for MPEG Video Recording on Digital VCR
593	Y. Senda	Results on Core experiment G.7 Chrominance scalability
594	W. Kameyama	Core Experiment Results on I.14
595	W. Kameyama	IDCT Mismatch Protection in Frequency Scalability
596	NHK	Consideration on applying MPEG system's streams to broadcasting use
597	NHK	Amendment to pel aspect ratio
598	NHK	Syntax modification for subsampling ratio
599	T. Murakami	Correction Method for Cell Loss and Bit Error in AAL Type1
600	A. Yamakata	Comments on MPEG 93/473, Profile architecture

601	J. Urano	A Proposal for a New 525-Progressive Test Sequence
602	JNC Profile	Study Group Consideration on Hierarchical Profile Architecture
603	JNC for WG11	Comments for New York Meeting
604	Juhola et al.	The VLC codes of macroblock types with spatial scalability
605	Johnson et. al.	Drift minimisation in the single encoding loop frequency scalable architecture using block based prediction/phase- shifting filters
606	Johnson et al.	Results to core experiment I14
607	Conte, Franceschini	Proposal for the insertion of DSM CC in the MPEG Systems syntax
608	MacInnis	Summary, analysis and implications of various systems transport stream proposals
609	MacInnis	Proposal for mapping MPEG into ATM cells
610	T. Savatier	Some Remaining Video Issues for MP@ML
611	J.Wasilewski	Proposal to Include Delta PCRs in MPEG-2 Transport Stream
612	J.Wasilewski	Syntax Proposal for MPEG-2 Transport Stream Program Specific Information
613	Tektronik Inc.	Macroblock Local Approaches to Chrominance Compatibility
614	Tektronik Inc.	Missing information and Inconsistencies in TM5, MPEG 2 Working Draft
615	T. Naveen	Comparison of Spatial and Frequency Scalabilities
616	T. Naveen	New improvements of Scalable Side Information
617	T. Kogure et al	Inputs for Audio Working Draft
618	F. Stumm	Updating mechanism for system maps
619	I. Rakhodai	Transport packet length
620	R. Aravind	Cleanup of AC-Leak Syntax and Specification
621	K.M.Illgner	Mobile communications and MPEG-4
622	S.Chouquet	Defining convenient cut points
623	S.Chouquet	An MPEG2 channel hopping time evaluation
624	D. Curet	An MPEG2 single layer transport syntax overhead evaluation
625	J.Zdepski	MPEG-2 video coding at HDTV resolution
626	G. Schamel et al	Demonstration of hierarchical coding of HDTV
627	P. Noordam	Table identification in program/PES streams
628	P. Noordam	Mapping a program stream to a transport stream
629	F. Stumm	General future proof description of table structures
630	P. Noordam	Table and maps on transport and program level
631	M.Nilsson	Semantics for skipped macroblocks in spatial scalability
632	M.Nilsson	Semantics for prediction of motion vector in spatial scalability
633	M.Nilsson	Syntax and semantic extensions for spatial scalability
634	M.Nilsson	Spatio-temporal weighting experiments
635	M.Nilsson	Accuracy requirements of upsampling
636	B. Loret	Experiment on spatial/temporal H.261/H.26x compatibility
637	J.Cochennec	About the transfer of MPEG transport packets in ATM
638	CNET	Cell Loss Resilience: Simulation results on concealment techniques
639	CNET	Simulation Results on AC-Prediction
640	T.Teichner	Issues for verification test
641	M.Nilsson	Frequency adapted spatio-temporal weighting
642	AFNOR	Resolutions of the French National Body
643	Jolivet	Transport packet length
644	Takahashi et al.	Result of bitstream decoding
645	Beaumont	Preliminary studies into ATM mapping of MPEG-2 transport layer packet
646	Boon et al.	Comments on working draft 4.0
647	Choon Lee et al.	A syntax extension for Fast Forward/Reverse at Digital Storage Media
648	Viscito	Field motion vector vertical range and PMVS
649	Kogure	Preliminary specification of DSM CC
650	Kogure	Initial proposal of DSM CC specification
651	Noordam	Generic user addressing mechanism
652	van der Meer	Copyright indication in MPEG-2
653	van der Meer	System Target Decoder for MPEG-2 systems
654	Erdem et al.	10-bit/8-bit amplitude scalable coding
655	Kogure	Performance evaluation of Main Profile at HDTV level and 4:2:2 coding
656	Feige	Report of informal subjective listening tests
657	Herpel	Concealement using spatial & SNR scalability
658	Herpel	SNR scalability vs. data partitioning for high error-rate channels
659	NNI	Resolutions of the Dutch National Body
660	Wise	High level syntax and semantics in MPEG-2
661	Franceschini et al	Relationship between Program Stream Description Table and the MHEG standard
662	Franceschini et al	Subtitling in MHEG streams

663	Fogg	Thoughts on "RAMPEG" vs. "ROMPEG"
664	Knoll	Motion vector refinement for the upper layer of a spatial scalable system
665	Noll	High quality audio coding: the ISO/MPEG standard(s)
666	SC29	Summary of voting on ISO/IEC JTC1 N2396, Proposal for a New Work Item: Very Low Bitrate Audio-Visual Coding
667	SC29/ITU-R	Target digital HDTV standard for use in the development of future systems for the studio and for international programme exchange
668	SC29/DIN	German contribution on some proposals for the next ISO/IEC JTC1/SC29 plenary meeting
669	SC29/JTAG2	Terminology matrix - version 2.1
670	SC29	Draft New Work Item Proposal: Low Bit-Rate Audio Coding
671	MacInnis	Data type and language identification
672	Puri et al.	Results of progressive HDTV coding with Main Profile Syntax
673	Puri et al.	Picture format scalable coding structures for HDTV
674	Wong et al.	Scalable coding harmonization based on applications
675	- not assigned -	
676	van der Meer	Concept for decoding and construction of FF/FR bitstreams
677	Uz et al.	MPEG-1 hardware verification at HDTV rates
678	Sun et al.	Experiments on the effect of losses of picture-type or f-code in picture headers
679	Sun et al.	Experiments on the effect of loss of quantizer matrices in picture headers
680	Uz	Data partitioning for VCR trick modes
681	Uz	Result of AC leak core experiment
682	Kwok et al.	Interlace <--> ProScan encoding and transmission experiment
683	CEC DG XIII	Hotel reservation forms for Brussels meeting
684	Pearson	VLBV94 Call for papers
685	Morris	Interworking between MPEG-1 Systems and MPEG-2 Systems
686	Reibman et al.	Comparison of the cell loss resilience of MPEG-2 main profile and AC-leaky prediction
687	McCann	Contribution to next profile definition
688	IPQ	Letter to JTC1 Secretariat
689	Hirose	Letter to SC29/WG Convenors
690	Fautier	Proposal for Simple Profile parameters
691	De Lameillicure et al	Simplification of the interlace-to-interlace upconversion in spatial scalability
692	Akiwumi-Assani et al.	Transport definition for US HDTV broadcast applications
693	Challapali et al	Constraints on MPEG2 syntax for the US HDTV standard
694	Stoll	Error concealment techniques for ISO MPEG -Audio layer I and II related to human sound perception
695	ISO	CD 639-2 Terminology - - Code for the representation of names of languages
696	Convenor	List of documents for New York
697	Tiernan et al.	MPEG-2 Systems - An analysis of clock recovery at the transport destination site
698	TS SG15 AVC	Report of discussion on ATM/AAL and MPEG-2 Systems
699	TS SG15 AVC	Proposed text for WD Anex C - Video Buffer Verifier
700	TS SG15 AVC	Summary of the discussion on AC-Leaky Prediction
701	Dolby Labs	Dolby AC-3 Multi-channel Audio coding listening session
702	Bosi-Todd	Dolby AC-3 Multi-channel Audio coding
703	Dolby Labs	Dolby AC-3 Multi-channel Audio coding demonstration
704	Takahashi et al.	Syntax proposal for FF/FR on Digital Storage Media
705	Wilson	Comments on MPEG Test Plan
706	TG 10/3	Informal communication to ISO/MPEG Audio Group
707	Wilson	Discussions within SMPTE on professional applications
708	Feige	Report on the MPEG/Audio MC informal subjective listening tests for Layer 1 (supplement to MPEG93/656)
709	ABSOC	Canadian requirements for digital television Systems
710	Un. of Hannover	Object oriented analysis-synthesis coding
711	Frezal	Towards a rapid and harmonious development of Digital Television
712	AT&T	Letter to the MPEG Audio chairman
713	Dolby	Letter to the MPEG Audio chairman
714	Noll	Letter to AT&T
715	Noll	Letter to Dolby
716	Stampleman	ISO/ITU Standard label registry
717	Brennon	Proposal for new registration procedure for MPEG Systems
718	Heuris Logic	Digital archive of New York MPEG submissions
719	Illgner et al.	Video coding in mobile networks
720	NHK	Consideration on copyright management for video data

721	Hidaka et al.	Allocation of test sequences simulation work MP@ML
722	DSM group	Proposed insertion of DSM CC syntax to Systems WD
723	Test group	Allocation of test sequences simulation work HDTV
724	Yasuda	Appreciation to timely activities of WG11
725	Lam	Some semantics for Picture_pan_scan_extension
726	Mc Laren	HDTV simulations results
727	Tominaga	Workshop on mobile multimedia communications

Questions to the Video and Implementation sub-groups

1. Questions to the Video

1) AC-leaky prediction
2) Other coding tools being experimented

3) Impact of B-pictures and Dual-prime at High Level on the coding efficiency

To choose among the following;

- not to define it as a profile at all
- not to define it now but to include it at a later stage if found necessary
- to define it as Main minus B pictures
- to define it as Main minus B-pictures and Dual-prime

4) Comparison of coding efficiency between

- 3 resolution scale scheme,
- 2 resolution scale + 1 SNR scale scheme

SNR scalability is newly identified functionality for Next Profile in addition to the three resolution scales which were listed in Sydney. See MPEG93/600, 687.

4) Possibility of integrating spatial scalability and frequency scalability

As per Mr. Holtzman's presentation.

5) To be confirmed

- Aspect ratio of existing or planned formats to be included in the table

0.7500	1440x1080, 16:9
0.7826	1440x1035, 16:9
1.0435	1920x1035, 16:9

- Flexible format relationship between layers (not only 2:1 but other ratios)

  See MPEG93/598.

6) Tools for scalability other than sscalabe

- 10/8 bit scalability
- Progressive/interlace hierarchy
- ...

7) Copyright, copy management indications

Is there a mechanism for allowing 2 bits of copy guard information to be defined in the picture header in a way which does not impact on the frozen status of MP@ML ? One suggestion is to define 2 of the 8 bits of extra_information_picture for this purpose. Alternatively, this information could be carried at the Systems level.

2. Questions to the Implementation

1) Impact of B-pictures and Dual-prime at High Level on the implementation cost

To choose among the following;

• not to define it as a profile at all
• not to define it now but to include it at a later stage if found necessary
• to define it as Main minus B pictures
• to define it as Main minus B-pictures and Dual-prime

Which elements of the Main Profile need to be excluded to define Simple Profile which is suitable for low cost applications; e.g. 8 Mbit/s DRAM at Main Level (see MPEG93/690)?

Assuming that Simple Profile is Main Profile minus some elements as stated above, is there significant implementation cost penalty incurred if we specify that Simple Profile at High Level should be able to decode Main Profile at Main Level bitstreams, and similarly Simple Profile at Main Level should be able to decode Main Profile at Low Level?

2) Quantization in High Level Parameter values: any particular thresholds?

To determine the necessity of additional Level parameters other than

horizontal_size_value	up to 2048 in multiples of 16
vertical_size_value	up to 1152 in multiples of 16
picture_rate	up to 60
Horizontal x Vertical. x Frame rate	up to 62.7 million pels/s

See the table in §3 1) in the main body of this report for existing or planned HDTV formats which should be considered.

3) The same question at Main Level

The discussion in the Requirements sub-group indicated impact of Dual-prime may be more significant at Main Level than High Level.

4) Level definition for EDTV and 483 lines

A possible Level structure to cover both EDTV and 483 lines for 525/60 is as follows

HL			1920x1088x30
EL	na		960x496x30
ML		na	720x480x30
LL			
	MP 4:2:0	NP 4:2:2	Parameters for 525/60

na: not applicable

Is there a threshold between 960x496x30 and 720x480x30 for Next Profile (4:2:2) so that we need separate Levels, or can they be covered by a single Level of 960x496x30?

5) Definition of Low Level for Next Profile

As a lowest layer of the hierarchical coding, the following is listed;

• 352x288x25 (MPEG-1, MPEG-2)
• 352x240x30 (MPEG-1, MPEG-2)
• 480x256x30 (quarter of EDTV, 4:2:2, MPEG-2)
• 352x288x30 (CIF, H.261)

Any suggestions to handle "quarter of EDTV" from implementation consideration?

6) Bit rates at High Level

Is there any threshold in implementation cost in coded data rate at High Level? If so, what is the value(s)? Time scale may be relevant?

7) Comparison of implementation cost between

- 3 resolution scale scheme,
- 2 resolution scale + 1 SNR scale scheme

SNR scalability is newly identified functionality for Next Profile in addition to the three resolution scales which were listed in Sydney. See MPEG93/600, 687.

What is the cost of introducing each additional layer of spatial scalability and is there any particular threshold? We are considering introducing a limit such as 1 or 2 on the maximum number of spatially scalable layers (in addition to the base layer) for the Next Profile.

What is the cost of introducing each additional layer of SNR scalability and is there any particular threshold? We are considering introducing a limit of about 2 or 3 on the total number of SNR and/or spatially scalable layers (in addition to the base layer) for the Next Profile.

8) Possibility of integrating spatial scalability and frequency scalability

As per Mr. Holtzman's presentation.

3. Questions to the Systems

Is there a mechanism for allowing 2 bits of copy guard information to be associated with each elementary stream within a Systems stream ? The information should be capable of being independently set for each elementary stream and should survive conversion between Program Stream and Transport Stream. Alternatively, this information could be carried at the Video level.

END

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
ORGANISATION INTERNATIONALE DE NORMALISATION

ISO/IEC JTC1/SC29/WG11
CODING OF MOVING PICTURES AND ASSOCIATED AUDIO

ISO/IEC JTC1/SC29/WG11 N0489
(Revised)
MPEG93/
16 July 1993

Source: **Requirements sub-group**
Title: **Agreements on Profile/Level**
Version: 10 AM, 16 July 1993

1. Level parameters

Upper bounds are as follows;

High (up to 60 Mbit/s) Note 4	Pels/line Lines/frame Frames/sec Pels/sec	1920 1152 60 62.7 million	1920 1152 60 62.7 million	1920 1152 60 62.7 million
High-1440 (up to 60 Mbit/s) Note 4	Pels/line Lines/frame Frames/sec Pels/sec	1440 1152 60 47.0 million	1440 1152 60 47.0 million	1440 1152 60 47.0 million
Main (up to 15 Mbit/s) Note 4	Pels/line Lines/frame Frames/sec Pels/sec	720 576 30 10.4 million	720 576 30 10.4 million	720 576 30 11.06 million (Note 2)
Low (up to 4 Mbit/s?)	Pels/line Lines/frame Frames/sec Pels/sec	352 288 30 2.53 Million	352 288 30 2.53 Million	Not decided
Level (Note 1)		Simple 4:2:0 single layer	Main 4:2:0 single layer	Next 4:2:2 scalable
		Profile		

Note 1 -Level for the Next profile indicates the upper layer of the two resolution scales.

Note 2 -720x512x30 has been considered to accommodate 483 active lines of 525/60 TV. The extension of the upper bound of the pel rate to cover half SCIF is an open issue.

Note 3 - Multiples of 16 up to the upper bound are supported in number of pels per line and number of lines per frame.

Note 4 - Data rates for other than MP@ML are to be determined .

2. Specifications for Next Profile

The Next Profile will support the following functionalities in addition to those of the Main Profile;

#	Functionality	NEXT	Main
1	Chroma format	4:2:2 and equivalent formats in other resolutions	4:2:0
2	Flexibility in bit rates (range of bit rates, CBR/VBR)	Independent control of bit rate on each layer is required.	Yes
3	Random access / Channel hopping	The same as main - the video decoder contributes only a part of the overall access time as seen by the viewer, thus no restrictions are set to the codec delay itself. A desirable figure for video and audio delay (*1) is less than 0.5 seconds.	Yes, but not necessarily at every frame
4	Editability	Yes as Main Profile	Yes, but not necessarily at every frame
5	Resilience	The same as Main - in addition increased error resilience and graceful degradation (*2) may be provided by use of the scalable coding. See §9.	Yes
6	Video windowing (e.g. 4:3 from 16:9 pictures)	16:9 needs to be provided for both HDTV and EDTV transmissions. For display on 4:3 (TV) receivers, signaling of the proportion of a 16:9 picture to be displayed is required. Video windowing should be possible in each layer.	Yes
7	Low delay	The same as Main.	Yes

8	Trick modes	Simple Fast Forward and Reverse are required. It should be possible that data rate in FF/FR mode be kept at less than normal mode rate.	Yes; those automatically supported by the basic syntax
9	Scalability (Hierarchical)	The following should be supported at High-1440 or High Levels; • up to 2 resolution scales • up to 4 scales in total as combination of resolution scales and SNR scales • up to 2 SNR scales at the upper resolution scale At Main Level, • up to 2 resolution scales • up to 3 scales in total as combination of resolution scales and SNR scales It shall be possible to decode single resolution scale as a degenerate case. Flexibility in formats at each layer (e.g. resolution ratio other than 2:1) is required for format compatibility and for the letter-box. Scalable technique with better efficiency than simulcast is required.	No
10	Compatibility	Forward compatibility with Main Profile is required. Backward compatibility with MPEG-2 (MP), MPEG-1 and H.261 is required to be possible when MPEG-2 (MP), MPEG-1 and H.261 is used for the base layer of multiple layers (*3). Downward / upward compatibility is inherent in scalable requirement.	Yes, but only MPEG-1 forward compatibility

11	Quality	It should be possible to trade subjective picture quality with bit rate and coding complexity. See §2.	
12	Flexibility in Implementation	Encoder flexibility in the set of modes provided, M value, in mode selection criteria, motion estimation, pre-analysis, quantization strategy, and other issues not being part of the standard. Target of software decoding of the lower level is foreseen for IT applications.	Yes
13	Copyright and copy management (new requirement)	The same as Main	To be contained in the Systems layer

*1 Time from the reception of the first coded bit and to the representation of visually recognizable picture

*2 Graceful degradation provides the ability for the progressive reduction of picture quality as the error rate in the bit stream increases. The reduction in picture quality may be continuous or in discrete stages, and may be achieved by mechanisms such as reduction in picture resolution or picture PSNR.

*3 Backward compatibility may not be an important consideration in some applications, particularly if it affects any other of the requirements.

Forward compatibility with MPEG2 MP@ML is required for conformance at corresponding level. Other levels may not require this functionality.

Forward compatibility with MPEG1 constrained parameter is required for conformance at this level. Other levels may not require this functionality.

3. Specifications for Simple Profile

Main Profile minus B-pictures. Dual Prime is retained in the Simple Profile.

4. Forward compatibility between different Profile@Level

X indicates the decoder must be able to decode the bitstream.

Decoder \ Bitstream	NP @ HL	NP @ H-14	NP @ ML	MP @ HL	MP @ H-14	MP @ ML	MP @ LL	SP @ HL	SP @ H-14	SP @ ML	SP @ LL
NP@HL	X										
NP@H-14	X	X									
NP@ML	X	X	X								
MP@HL	X			X							
MP@H-14	X	X		X	X						
MP@ML	X	X	X	X	X	X		X*	X*		
MP@LL	X	X	X	X	X	X	X	X*	X*	X*	
SP@HL	X			X				X			
SP@H-14	X	X		X	X			X	X		
SP@ML	X	X	X	X	X	X		X	X	X	
SP@LL	X	X	X	X	X	X	X	X	X	X	X

* Note that SP@HL and SP@H-14 decoders are required to decode MP@ML and MP@LL bitstreams, and similarly SP@ML decoders are required to decode MP@LL bitstreams.

5. Coding tools not included in defined Profiles

There are some coding tools (4:4:4, 10/8 bit scalability, etc.) which are defined in the syntax but not included in any Profile. These tools may be included in one or other Profiles which can be added in the future if found necessary according to the existing procedures (e.g. in form of Amendment). Another possibility is that their use may be defined in application standards.

The November 1993 CD includes only Simple, Main and Next Profiles.

6. Pixel aspect ratio of existing or planned formats

The following values should be included in the WD.

- 0.7500 1440x1080, 16:9
- 0.7826 1440x1035, 16:9
- 1.0435 1920x1035, 16:9

7. Open issues

1) Appropriate naming for Profiles and Levels other than Main
2) Upper bound for the base layer of the Next Profile in terms of resolution and bit rates.
3) Create a table which relates syntactic elements and parameter values with Profiles and Levels.
4) Compatibility with SCIF video format
5) Bit rate bounds for Profiles and Levels other than MP@ML.

END